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# Radiological Safety Regulations

Revised 1951



NavMed P-1325

Bureau of Medicine and Surgery  
U. S. Navy Department  
Washington, D. C.

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# Navy Department Radiological Safety Regulations

Revised 1951

## Chapter I. INTRODUCTION

### 1-1 GENERAL

(1) The regulations and permissible dosages given herein are for observance in peacetime laboratory and industrial operations in all naval establishments dealing with ionizing radiations or radioactive materials. They are in particular, designed for the protection of those constantly exposed to ionizing radiation in the course of their routine work. Strict application to patients in clinical radiology is not appropriate and modifications may be appropriate in this and other special circumstances. The proposed values will vary with advancements in this field and therefore will require constant revision.

(2) Persons not under the control of the Navy Department will comply in all respects with these regulations when engaged in a naval sponsored operation.

### 1-2 RADIOACTIVE AREA

(1) Generally speaking, a radioactive area may be defined as any area where the radiation intensity exceeds normal background radiation.

(2) However, for practical purposes, in the absence of any detectable contamination with an alpha-emitting material, the following modifications are authorized for use in special field operations:

(a) Any area where the total beta-gamma radiation intensity consistently does not exceed 0.005 r/24 hrs. may be considered nonradioactive, and routine radiation monitoring may be dispensed with.

(b) Personnel physically qualified for duty, who have not previously been exposed regularly to ionizing radiation or worked with radioactive isotopes, may be detailed for a period of time not to exceed 1 year to any area where the total beta-gamma radiation intensity consistently does not exceed 0.005 r/24 hrs. without special medical examinations or personnel dosimetry; however, routine radiation monitoring will be performed as prescribed by the Radiological Defense Staff. Nonexempt personnel will be required to take the physical examinations as required by chapter 4, and to wear regulation film badges.

### 1-3 RESPONSIBILITY

The responsibility for the safety of personnel in a radioactive area rests with the commanding officer who acts on the advice of his Radiological Defense Staff. This Staff normally consists of line and medical officers especially trained in the evaluation of radiological hazards. Their decisions are based on monitoring and/or laboratory procedures.

## Chapter 2. RADIOLOGICAL HAZARDS

2-1 The harmful effects of x-, gamma, and corpuscular or particulate radiations are considered to be due to their ionizing effect on living tissues and result in cell injury or death. It is beyond the scope of this publication to provide an extensive discussion of the biological effects of ionizing radiations. However, for the purpose of clarifying these safety regulations, a few of the known fundamental principles are briefly presented. All types of tissues are susceptible to this ionization effect in varying degrees, blood-forming tissues being among the most sensitive. Regardless of the type of radiation involved, the result in the cell is apparently the same. The degree of injury depends primarily upon the quantity of radiation energy absorbed by the cell. Chronic or repeated over-exposures may lead to cumulative biological effects. Needless exposure to any radiation should be avoided.

2-2 In the field of Radiological Safety, two types of radiation hazards are recognized:

(1) External radiation is that in which the source is located outside the body. Such radiation may be x-rays, gamma rays, neutrons, or beta particles. These radiations are an external hazard because of their ability to penetrate the tissues. Beta particles, although they have a limited range in tissue, may damage the skin. Alpha particles, because of their insignificant penetration, are not considered an external hazard.

Even though it may seldom happen that the whole body is subjected uniformly to external radiation, it is nevertheless necessary, in the interest of safety to assume that this always takes place and to regard each

exposure to external radiation as total body irradiation rather than limited body irradiation such as occurs in x-ray or radium therapy. An exception to this statement is exposure of the hands to beta particles.

It is evident that further irradiation from an external source ceases immediately upon removal of the source, removal of the individual from the source, or the insertion of adequate shielding between the source and the individual.

(2) Internal radiation is that type of hazard which exists when radioactive materials enter the body by ingestion, inhalation, or through the skin as by way of an open wound. Materials which emit gamma, beta, and/or alpha particles, such as radium, plutonium, or other radioactive elements including fission products, may be absorbed and deposited within the body. These act as damaging agents which injure or destroy blood-forming organs and other tissues. Clinical evidence of injury may be apparent in a few weeks in severe cases, or may not appear for years in cases where smaller amounts of radioactive material have been absorbed.

With internal radiation, in contrast to external radiation, the source is fixed in the tissues and its removal is limited by the rate of excretion of the element from the body and the natural radioactive decay of the element.

Under conditions of atomic warfare, and in connection with industrial and laboratory atomic energy operations, it is possible for an individual to be exposed to both external and internal radiation hazards.

## Chapter 3. MAXIMUM PERMISSIBLE EXPOSURES

3-1 Although the term "tolerance" is used in reference to dosage of radiation, there is no proof that living tissues are completely tolerant to ionizing radiation even in the minute amounts everywhere present as normal background radiation (cosmic rays, radon, et cetera). The term "Maximum Permissible Exposure" is a better term. Accordingly, the word "tolerance" will be replaced by the term "Maximum Permissible Exposure (MPE)."

The MPE's do not represent limits within which there can be complete disregard of exposure. The exposure to ionizing radiation should be kept to an absolute minimum in all circumstances.

### 3-2 EXTERNAL RADIATION

(1) The MPE for total body exposure is 0.3 r (0.3 rep) integrated over a period of a week acquired in a single or accumulated dose. It is recommended that exposure levels of 0.05 r (0.05 rep) or less per 24-hour period be maintained for routine operations. Integrated exposures greater than 0.3 r/week require removal of the individual from further exposure until "recovery" can be effected, using 1 week as the time index of exposure.

(2) A local external radiation MPE of 1.0 rep/week is established for beta radiation exposure to the hands.

(3) In the case of individuals who will be working with external radiation for a period of time not to exceed 2 years, the MPE is established as 1.25 r/month. This may be obtained in a single exposure provided there is not additional exposure to radiation during that month.

(4) In case of fires or accidental spills where individuals such as firemen, who are not being regularly exposed to ionizing radiation, may be exposed in an emergency, an MPE of 5 r is allowable at one time, provided a total dosage of 15 r per year is not exceeded and provided proper protective and indicative device such as masks or respirators and self-reading dosimeters are worn. (See Section 6-4.)

(5) Exposure to high energy particles from piles or accelerators such as cyclotrons, betatrons, et cetera, require special MPE considerations not within the scope of these regulations.

### 3-3 INTERNAL RADIATION

(1) Lifetime allowances for the bodily deposition of certain alpha-emitting materials:

(a) Radium.--The deposition of 0.1 microgram of radium within the body is considered the lifetime allowance.

(b) Plutonium.--The deposition of 0.5 microgram of plutonium within the tissues of the body is considered the lifetime allowance.

(c) Others.--As lifetime allowances for bodily deposition of other elements are determined they will be added to these regulations.

(2) Maximum allowable air concentrations.--In order to prevent the deposition of amounts greater than established allowances of isotopes within the body and to prevent radiation damage from beta-gamma emitters as well as alpha emitters the following air concentrations shall not be exceeded in areas occupied by personnel for any purpose:

(a) Radon.--The allowances for atmospheric contamination shall not exceed  $10^{-11}$  curie per liter of air. This actually is radon from both air-borne and surface radium contamination.

(b) Plutonium, radium, and other alpha-emitting heavy isotopes.--The allowable atmospheric concentrations for these elements is not greater than  $5 \times 10^{-12}$  microcurie/cc. of air for continuous exposure for 1 year.

(c) Beta and/or gamma emitters.--The maximum permissible concentration of air contamination by the more hazardous beta-gamma emitting isotopes such as iodine, strontium, barium, et cetera, is considered

to be approximately  $10^{-9}$  microcurie/cc. of air. When the air concentration reaches this level masks shall be worn, and should the concentration increase by a factor of 10, (i.e. reach a concentration of  $10^{-8}$  microcurie/cc.), the area shall be evacuated.

#### 3-4 MAXIMUM PERMISSIBLE LEVEL OF RADIOACTIVITY IN FOOD OR WATER

No food or water known to be or suspected of being radioactively contaminated shall be consumed until it has been carefully monitored. The level of food contamination by radioactive materials (beta-gamma or alpha emitters) which is considered to be significant is  $10^{-7}$  microcurie/cc. or gram.

## Chapter 4. MEDICAL EXAMINATIONS

### 4-1 PREFEXAMINATIONS

All personnel directly engaged in or considered for assignment to duty requiring regular exposure to ionizing radiation or the handling of radioactive materials except as authorized in paragraph 1-2 (2) (a) shall have the following preexamination:

(1) Complete physical, including urinalysis and chest x-ray. If a similar examination has been conducted within the past 6 months it will be accepted provided a record of such examination is available for part of the individual's record.

(2) A complete blood count, including a leukocyte differential count, will be made on 3 successive days for the purpose of establishing a normal base-line for later use in the evaluation and detection of early radiation injury. Blood specimens for this purpose shall be collected on an empty stomach immediately prior to lunch. Previous blood counts will not be accepted for this preexamination requirement.

(3) A radiochemical urinalysis on all who have previously engaged in the handling of plutonium, uranium, or radioactive rare earths.

(4) Breath samples for the determination of radon concentration on all personnel who will be engaged in the handling of radium salts or compounds not hermetically sealed.

### 4-2 PHYSICAL REQUIREMENTS

(1) The general physical requirements are those for active duty in the military service or for Civil Service employment.

(2) In addition to failure to meet the general physical requirements, the follow-

ing findings are considered disqualifying:

(a) All exposed wounds, whether lacerations, abrasions, or ulcerations, for personnel handling radioactive materials not hermetically sealed.

(b) Total white blood cell counts below 4,000 or above 12,000. In cases where abnormal white cell counts may be due to transient diseases or other conditions, reexaminations shall be made upon recovery.

(c) Persistently abnormal leukocyte differential counts.

(d) Total red blood cell counts below 3.5 million or above 6.5 million.

(e) The presence of plutonium, uranium, or radioactive rare earths in the urine.

(f) The presence of more than  $5 \times 10^{-13}$  curie/liter of radon in expired air.

(g) Any evidence of previous radiation injury which is considered disqualifying by the medical examiner.

### 4-3 FOLLOW-UP EXAMINATION

All personnel engaged in work involving regular exposure to ionizing radiation or handling of radioactive materials except as authorized in paragraph 1-2 (2) (a), shall have the following reexaminations:

(1) Physical examinations at the discretion of the Radiological Medical Officer. Examiners will be alert for signs of chronic radiation damage such as lack of vitality, loss of appetite, weight loss, cracking of the skin of fingers, and excessive longitudinal corrugation and brittleness of the fingernails. These findings shall be recorded on the physical examination form. Chest x-rays and routine urinalyses are not considered

an essential part of the reexamination of individuals engaged in working with radioactive materials or radiation unless specifically indicated.

(2) Complete blood counts including leukocyte differential counts, shall be made when indicated at intervals not greater than 4 months, the specimens being collected immediately prior to lunch.

(3) Where appropriate, radiochemical urinalyses shall be done at intervals of 4 months.

(4) Breath samples shall be collected from personnel engaged in the handling of radium salts or radium compounds, not hermetically sealed, at intervals of 6 months. These samples shall be submitted to the National Bureau of Standards for radioanalysis in accordance with their instructions.

#### 4-4 SPECIAL OR EMERGENCY EXAMINATIONS

(1) Over-exposure to external radiation.--Any individual receiving external radiation greater than 25 r in a single exposure requires immediate hospital evaluation.

(2) Possible over-exposure to internal radiation hazards.--In the event of circumstances whereby personnel are possibly exposed to ingestion or inhalation of significant amounts of radioactive material special radiochemical examinations shall be performed as indicated.

(3) Individuals showing abnormal findings in any special or routine follow-up examinations shall be removed from further exposure to radiation and given an exhaustive study.

#### 4-5 RECORDING OF EXAMINATIONS

(1) The results of physical and laboratory examinations given preliminary to the individuals' commencing radiation work and subsequent to his final separation from all such duties shall be recorded on Standard Forms 88 and 89 and shall be transmitted through regular channels to the activity normally receiving those forms. Interim and special examinations shall be recorded on the NavMed H-8 of the Health Record or the Industrial Health Jacket as appropriate. Total previous exposure to radiation and type of work performed shall be recorded on Standard Form 88 under "remarks."

(2) Monthly accumulative reports of radiation exposure shall be noted on the current NavMed H-8 indicating exposure dosage during current month, number of days exposed during current month, and the cumulative total exposure to date.

(3) Total accumulative exposure in roentgens and total time involved in radiation work, described in days, shall be noted on the NavMed H-8 under the following conditions:

(a) Detachment or transfer.

(b) Termination of Health Record.

(c) Opening of a new Health Record.

Upon the forwarding of medical history sheets to the Bureau of Medicine and Surgery an abstract of the total cumulative radiation exposure, and total time involved in days, shall be made a part of the medical abstract and entered upon the new NavMed H-8 if indicated. Attention is invited to article 16-58(5) Manual of the Medical Department.

## Chapter 5. PHOTOGRAPHIC DOSIMETRY

5-1 Photographic dosimetry is the determination of exposure of an individual to ionizing radiation by the use of photographic emulsions of requisite sensitivity to x- and gamma radiation. Eventually photographic dosimetry will be extended to measure other radiations as developmental studies culminate.

5-2 A photographic dosimetry unit consists of a densitometer (a photographic analyzer for the accurate measurement of the darkening of films as the result of exposure to radiation), x-ray developing facilities, special films, and film badge holders. At least one x-ray technician qualified in photodosimetry, XRT(P), will work with the unit.

5-3 The densitometers are available from the Naval Medical Supply Depot, Edgewater, N. J. upon approval of the Bureau of Medicine and Surgery, Code 74, at no cost to the local medical or dental facility. Industrial type K films in dental size packets along with calibrated film and special film badge holders are available from Naval Radiological Defense Laboratory, San Francisco, Calif.

5-4 The purpose of the Photographic Dosimetry Program is as follows:

(1) To provide an integrating radiation dosimeter as a part of an over-all radiological safety program for the protection of personnel exposed to ionizing radiation.

(2) To provide a permanent record of the exposure of personnel to ionizing radiation which shall become a part of the individual's medical record.

(3) To provide training and experience of potential military value in radiological safety.

### 5-5 PROGRAM ESTABLISHMENT

Photographic dosimetry units shall be established by naval medical facilities to an extent sufficient to provide film badge services for all service and civilian personnel under naval cognizance regularly exposed to ionizing radiation, whether from the handling of radioactive materials, from medical, dental, or industrial x-rays, or from any other exposures to ionizing radiation. This shall be a responsibility of the highest staff medical officer present ashore if a shore activity or afloat if an activity afloat. Fleet Marine Force medical facilities shall be considered as an activity afloat for this purpose.

### 5-6 WEARING OF FILM BADGES

Film badges shall be worn by all naval personnel (service and civilian) who are engaged in the handling of radioactive materials or working with radiation and by those who enter a radioactive area.

### 5-7 PROCESSING

Film badges will be processed and read at the end of every other calendar week, except that processing intervals may be varied at the discretion of a qualified radiologist or radiological safety medical officer, with a maximum interval period of 4 weeks.

## 5-8 OVER-EXPOSURE

Individuals whose exposure has exceeded the MPE set forth in paragraph 3-3(1) shall be excluded from further exposure to ionizing radiation until sufficient time has elapsed to bring his total exposure within the MPE. Each day free from exposure will be considered to compensate for 0.05 r over-exposure. For example, an individual who has received an exposure of 0.45 r in a period of 1 week has an over-exposure of 0.15 r. The over-exposure divided by the daily recovery factor of 0.05 r gives the number of days he should be removed from further exposure:  $0.15/0.05$  equals 3 days. However, to determine the MPE for the week following the over-exposure, the actual over-exposure must be deducted from the standard MPE of 0.3 r/week, i.e.,  $0.3 \text{ r} \text{ minus } 0.15 \text{ r}$  equals 0.15 r allowable exposure for the week in question. Where exposure of the individual to x- or gamma radiation is likely to exceed the MPE the film badges should be augmented by the use of pocket dosimeters.

## 5-9 PHOTODOSIMETRY REPORTS

(1) (a) An Annual Photodosimetry Report shall be submitted at the end of each calendar year by all activities having a photodosimetry program and by any activity that utilizes the photodosimetry film badge. This annual report shall consist of only those actually "on board" at the end of the calendar year, shall originate from the cognizant Medical Department representative or the Radiological Health Officer; and shall be submitted via official channels to the Bureau of Medicine and Surgery, Code 74, not later than 15 January.

(b) Those activities NOT having a photodosimetry program or NOT utilizing the photodosimetry film badge shall submit

this Annual Report only in the case of personnel "on board" who were exposed elsewhere during the calendar year. This will require a careful study of the health records of all personnel attached and the submission of the data required by paragraph 5-9(2) as recorded on the current Medical History Sheets, NavMed H-8. Negative reports are not required.

(2) Until such time as a specific NavMed form is distributed, the Annual Photodosimetry Report shall consist of a list of all exposed personnel, service and civilian, on board, indicating in columns the full name, rank or rate, serial or service number, number of weeks employed in radiological work during the current year, total cumulative open window exposure (beta plus soft gamma or x-ray) in roentgens and the total cumulative closed window exposure (hard gamma or x-ray) in roentgens during the calendar year.

(3) Special Photodosimetry Report.--In the event that any individual receives greater exposure than 0.3 r within a period of any one week of the calendar year, which shall be determined at the time of processing and reading of the film badges, the circumstances shall be explained immediately in a Special Photodosimetry Report. Film badges that are processed and read on a 2 weeks' basis should not exceed 0.6 r, on a 4 weeks' basis should not exceed 1.20 r for that period, et cetera. In any case of greater readings it must be assumed that over-exposure has taken place within the period processed and read and requires the submission of the Special Photodosimetry Report. This special report shall be forwarded via official channels to the Bureau of Medicine and Surgery, Code 74.

## Chapter 6. PROTECTION OF PERSONNEL

### 6-1 PROTECTIVE CLOTHING

(1) Each naval activity, where radioactive materials are handled, shall provide protective clothing for the personnel so engaged. The type required will vary with the local situation and may include:

- (a) A plastic or hard hat, or other head covering as appropriate.
- (b) Safety glasses.
- (c) Suitable washable and/or disposable outer garments.
- (d) Underwear.
- (e) Appropriate footwear and/or disposable canvas "booties."

(f) Socks.

(g) Gloves, canvas type for manual labor; surgical or other rubber gloves for laboratory work.

(2) Protective clothing which is contaminated so that it emits a radiation level of more than 0.005 r/working day, gamma plus beta, or is contaminated with an alpha-emitting material shall not be worn but shall be decontaminated or disposed of.

### 6-2 LAUNDERING

(1) In order that regular laundry facilities, which are normally not monitored, will not become significantly contaminated, working clothing which is to be laundered and which reads over 0.005 r/working day of beta plus gamma or is contaminated with an alpha-emitting substance shall be laundered in a special facility subject to routine monitoring. If, after repeated laundering, contaminated work clothing still reads over 0.005 r/beta plus gamma/working day or contains any detectable alpha-emitting substance, it shall

be collected and disposed of properly. Under no circumstances will contaminated articles of clothing be disposed of by burning.

(2) Certain activities may find it more economical to appropriately store washed clothing that is still contaminated with isotopes suspected of being relatively short-lived, thus taking advantage of the decay factor in decontamination. Clothing which does not decay below the permissible level in approximately 6 months should be disposed of properly.

### 6-3 FISSION PRODUCTS

(1) For fission products fields the following are considered as limits specified for clothing in paragraph 6-2 on the basis of a 40-hour week (for Radiological Warfare fields the limit is 2 mr/hr indicated beta plus gamma reading on all G-M tubes).

(a) Thin side wall G-M tube (30-40 mg./cm.<sup>2</sup>) - 7 mr/hr indicated beta plus gamma reading when measured with the tube parallel and not more than 6 inches from the contaminated surface.

(b) Thin end window. G-M tube (2-4 mg./cm.<sup>2</sup>) - 2 mr/hr indicated beta plus gamma reading when measured with the tube vertical and not more than 6 inches from the contaminated surface.

(2) The following radiac instruments have approximately 30-40 mg./cm.<sup>2</sup> thin side wall G-M tubes:

- (a) AN/PDR-5.
- (b) AN/PDR-7.
- (c) AN/PDR-26.
- (d) AN/PDR-T2.
- (e) IM-39/PD.

(3) The following radiac instruments have approximately 2-4 mg./cm.<sup>2</sup> end window G-M tubes:

- (a) AN/PDR-8.
- (b) AN/PDR-8A.
- (c) AN/PDR-8B.
- (d) AN/PDR-8C.
- (e) AN/PDR-27.
- (f) AN/PDR-27A.

#### 6-4 DECONTAMINATION PROCEDURES

(1) Information concerning specific decontamination procedures or personnel decontamination may be obtained from Naval Radiological Defense Laboratory, San Francisco Naval Shipyard, San Francisco 24, Calif., and by referral to the Shipyard Industrial Radiological Manual, BuShips.

(2) Drydocks in which work has been done on contaminated ships shall be frequently monitored. The MPE limit for areas, fittings, and equipment of the drydock is established at 0.015 r per 24 hours, gamma plus beta. There must be no alpha radiation detectable by suitable low level alpha meters or alpha sensitive film. Areas and materials reading in excess of this level shall be decontaminated.

Acids and other waste materials which have been used to decontaminate ship's salt-water systems or other equipment shall be placed in suitable containers and dumped at sea. Care will be taken to avoid spilling such waste solutions en route.

All machinery and equipment including hand tools used in working on contaminated vessels and equipment shall be monitored and decontaminated if the radiation level is above 0.015 r/24 hr, gamma plus beta, or if alpha contamination is present. If such materials cannot be rendered safe by decontamination, they will be properly safeguarded or disposed of as appropriate.

All decontamination procedures except personnel decontamination shall be carried out under the supervision of a qualified Radiological Safety Officer, who shall be advised by the Radiological Medical Officer.

Vehicles used for transporting radioactive material should also be carefully monitored. The use of wooden-bed trucks and passenger vehicles should be avoided. Truck beds, carts, and other carriers may be covered

with a tarpaulin or canvas before receiving material from radioactive areas or ships. These protective covers may be reused until they become contaminated by alpha emitters or have a level of 0.05 r/24 hr, gamma plus beta, at which time they shall be disposed of by sinking at sea.

Likewise, surfaces of small boats which may become contaminated shall also be monitored and decontaminated as necessary.

#### 6-5 PROTECTION AGAINST INHALATION HAZARDS

(1) Personnel will wear masks when indicated. It is not necessary to wear respirators while performing such duties as monitoring or inspection under dust-free conditions, however, they will frequently be needed for firemen fighting fires where there is an inhalation hazard and for other emergency uses.

(2) It must be borne in mind that the following operations in a radioactive area are known to increase respiratory hazard: cutting, burning, welding, dry sweeping, filing, grinding, scraping, sand blasting, and/or paint chipping.

(3) For work in a radioactive area where an adequate supply of oxygen is present and where there are no toxic fumes the following masks are authorized for use:

(a) Army Assault Mask with M-11, E-12, or M-10-A1 cannister.

(b) Navy Combat Mask, MK-IV with B-2 cannister.

(4) If radioactivity is present in air in which a deficiency of oxygen exists or is suspected to exist, or where noxious gases are present, the following breathing apparatus shall be authorized to be used:

(a) Rescue breathing apparatus.

(b) Positive pressure breathing mask with uncontaminated air or oxygen supply.

(c) Mask with self-contained air or oxygen supply.

If such equipment is used, it is essential that personnel be carefully instructed in its use and be familiar with the safety precautions pertaining thereto.

(5) After using the Army Assault Mask or the Navy Combat Mask with the appropriate cannister all cannisters will be monitored and disposed of if contaminated.

#### 6-6 SAFETY REGULATIONS FOR WORK

(1) Supplements. It is recommended that the following publications be used as supplements to these regulations:

Handbook #23, "Radium Protection." National Bureau of Standards.

Handbook #27, "Safe Handling of Radioactive Luminous Compounds." National Bureau of Standards.

Handbook #41, "Medical X-ray Protection up to Two Million Volts." National Bureau of Standards.

Handbook #42, "Safe Handling of Radioactive Isotopes." National Bureau of Standards.

"Safety Code for the Industrial Use of X-Rays." American Standards Association.

All naval activities using radium for therapy or industrial radiography shall use Handbook #23. Those using radioactive luminous compounds shall use Handbook #27 and those using x-ray for diagnosis, therapy, industrial use, or otherwise shall use Handbook #41 and the American Standards Association Safety Code. Activities using radioactive isotopes or radium paints for clinical, industrial, or other purposes shall use Handbook #42. All conflicting maximum permissible exposures listed in this supplementary material shall be superseded by the MPE's in Radiological Safety Regulations.

These regulations and the supplements thereto shall also apply to all naval activities employing x-ray or radioactive material as may be appropriate.

(2) The Change Station. -- To insure that individuals are adequately protected, procedures for monitoring and personnel decontamination must be developed and followed at every activity where particulate radioactive contamination is possible. These procedures should be flexible since a particular activity may be working with a serious hazard such as plutonium, long-lived alpha emitters, relatively long-lived isotopes, fission pro-

ducts, or radium dial paint, or may be involved in only a slight hazard such as small amounts of short-lived isotopes for therapy or tracer amounts of other radioactive isotopes.

A change station or decontamination procedure must be established rigid enough to protect personnel from the particular hazard concerned. A typical system for more hazardous operations is as follows: There will be provided a noncontaminated locker room where workers and others may remove their street clothing. They will then enter a "Clean" room containing lockers for their work clothing and situated adjacent to the check-in desk and film badge shelves. Here they receive all necessary equipment as well as their protective clothing and film badges, are checked in, and proceed to work.

Upon returning from work, if disposable gloves and canvas booties are worn, the men place these in a suitable container in a separate room reserved for returning personnel who may be contaminated. They are then monitored and their film badges removed. If the badges are uncontaminated, they are removed by the monitor to the check-in desk. If they are contaminated, an attempt is made to remove the film packet in an uncontaminated condition for development and a note is made in the proper log that the holder was contaminated slightly, moderately or extremely. Tools, masks, helmets, rubber boots, and nondisposable gloves are returned here, also, for monitoring and decontamination. If individuals are found to be contaminated, their work clothing is removed and deposited for laundering.

A separate shower facility will be provided for individuals found to be contaminated. Handwashing facilities, including brushes for scrubbing the nails, will be provided separately from the showers. After grease, dirt, and contamination are removed from the hands by repeated scrubbing with soap and water, and other pertinent chemicals if necessary, the workers will proceed to the shower and wash the body, repeatedly soaping and rinsing and paying particular attention to the hair and scalp. They will then dry

themselves in the shower room and be completely monitored, with special attention being given to the hair, hands, and the soles of the feet. Showers will be repeated as necessary until all contamination has been removed from the body as indicated by proper monitoring.

Head facilities will be provided on both the clean and contaminated sides of the change station. It is not necessary that complete personnel decontamination be carried out prior to using such facilities. The worker should remove his gloves, roll his sleeves to the elbow, and thoroughly scrub his forearms and hands before utilizing the head facilities.

It is pointed out that after such a "change station" has been in use for a relatively short time shower drains, laundry, et cetera may become increasingly contaminated. It is suggested that where appropriate in order to avoid such contamination of the sewage system, suitable arrangements be made to establish the "change station" and laundry aboard a barge or lighter. It is considered that in present operations the waste water may be allowed to drain into the harbor from such a change station without hazard. A lighter so equipped would have the further advantage in that it could be moored in the immediate vicinity of a contaminated vessel for greater convenience to personnel. Proper records shall be kept of all monitoring and decontamination procedures.

(3) Monitoring.--Monitoring of radioactive areas shall be done at regular intervals for the protection of personnel working in such areas. It is obvious that such areas will differ considerably in degree, type, and rate of change of radioactivity. Consequently, one or more members of the Radiological Defense Staff will determine regular, special, or emergency monitoring intervals for all radioactive areas under their cognizance. Personally owned articles which may become contaminated shall not be permitted in any radioactive area. Tools and equipment used in these areas shall be segregated and monitored by the Radiological Safety Officer. When such material is contaminated so that it emits

a radiation level of more than 0.05 r/working day, gamma plus beta, or is contaminated with an alpha-emitting material, it shall be decontaminated or disposed of.

(4) Access to Areas.--Insofar as possible, access to a radioactive area should be limited to working personnel only. Sightseeing and other nonessential activities should be discouraged. Measures shall be taken to prevent souvenir hunting and looting. Areas which have been found radioactive and areas in which radioactive vessels are moored should be restricted to official business only. Sentries or guards shall be posted where necessary to prevent access by unauthorized persons.

(5) Shifting contamination.--Men are warned to avoid stepping in pools of water since it is possible for "skifting" contamination to occur as fission products which are washed by rain from one place to another. Likewise, attention must be paid to avoid dust clouds and piles of rust, paint scale, and other debris which may give rise to a dust hazard or be tracked about, as such material is apt to be highly contaminated.

(6) Ingestion.--There must be absolutely no eating, drinking, smoking, or gum chewing while working in a radioactive area. Only when personnel have left the area and have been thoroughly decontaminated may this be permitted. It may be necessary to prescribe such hours of duty that these regulations may be observed without undue hardship to personnel.

(7) General.--Head facilities on the contaminated side of the change station shall be monitored daily. If the level of total radiation is more than 0.05 r per 24 hours, beta plus gamma, or when alpha contamination is present, the station shall be decontaminated.

It shall be the duty of the senior member of the working party to insure that no member thereof is allowed to work with any wound or open lesion on his hands or other exposed portion of the body.

All workers and inspectors shall be instructed that in the event of damage to his clothing, gloves, or other protective equipment he shall leave the radioactive area or

vessel immediately and return to the change station.

Handling of objects must be kept to a minimum. Cotton gloves give some protection against contamination and injury to hands and should be worn at all times where contamination is likely. It must be remembered that distance is the best protection against external radiation.

No clothing shall be removed or changed while in a radioactive area.

"Overhead" personnel, that is, those whose duties are the care of change station, laundry, or any other assignment which requires contact with contaminated material shall be provided with film badges and dosimeters, monitored and decontaminated just as if working in a radioactive area or vessel requiring such protection.

Diving operations may be conducted as necessary. Prior to each descent, divers shall be processed through the change station like all other personnel. They will wear on their person one film badge and two pocket dosimeters. There must be no open wound on their body. The air supply of the diving gear must be located so as to avoid the intake of air contaminated with radioactive dust. Upon surfacing, divers shall be monitored and required to proceed through the change station in the usual manner. Their diving dress shall be monitored and decontaminated if over 0.05 r per 24 hours, gamma plus beta, or if any alpha contamination is detected.

#### 6-7 VACATIONS

Since in low intensity irradiation the interval between two exposures offers the possibility that certain regenerative processes may come into play, it is suggested that personnel coming under the jurisdiction of these regulations should divide their annual leave into at least two but no more than three equal parts taken at 6- or 4-month intervals, except for emergencies.

#### 6-8 SPECIAL REGULATIONS FOR CONTAMINATED SHIPS OR MATERIAL

All radiological safety regulations in other sections of this publication shall be held to apply as well for work with contam-

inated vessels and material. If possible, contaminated vessels should be moored in such locations that prevailing winds will not carry contaminated dust, spray, or other materials toward any inhabited area or roadway. It must be carefully determined before a dust-producing operation is begun that no injury to persons nor contamination of property can result. Should it be desired to dry dock the contaminated vessels the utmost care must be taken in order that working and other personnel not be exposed to excessive radiation nor that the dry dock itself be unnecessarily contaminated. All contaminated debris must be carefully collected and disposed of properly.

Ships' ventilation systems are not to be operated except as approved by the Radiological Safety Officer and Radiological Medical Officer jointly nor will portable blowers be used without such clearance. Extreme care must be taken in handling compressed air lines to avoid spreading contaminated dust by the air stream from a leaking or parted line. Dust samples should be taken in a number of areas throughout the ship prior to extensive operations. Careful interpretation of this hazard will be made by the Radiological Medical Officer on the basis of all information available.

Since a fire in a radioactive vessel or area would be fraught with serious consequences, every precaution will be taken to prevent fire. Cutting, burning, welding, and similar activities should be kept to a minimum and then done only by properly protected, qualified personnel when adequate fire-fighting equipment is immediately at hand. Adjacent spaces should be examined to make sure that inflammable materials are not stored against the other side of bulkheads subjected to heat. If cutting, burning, or welding must be performed the Radiological Medical Officer will survey the situation and make recommendations to the Radiological Safety Officer as to need for special ventilation apparatus, type of mask to be used, and other necessary precautions.

Dry sweeping of a radioactive space will not be done. This will not apply to small localized operations for collecting dust sam-

ples for analysis. If it is necessary to clean a space this can be done by swabbing or flushing down. Swabs will not be wrung out by hand but may be hung on the lifelines to dry. The use of the rotary wire brush is

specifically forbidden as being too dangerous in all respects. Working parties will make certain, prior to leaving a radioactive building or vessel, that no one is left aboard locked in a compartment.

## Chapter 7. USE OF RADIOACTIVE ISOTOPES

7-1 Radioactive isotopes may not be used for any purpose in any naval installation without prior approval of the cognizant Bureau upon the advice of the Bureau of Medicine and Surgery.

### 7-2 ISOTOPE COMMITTEE

Naval hospitals or medical institutions desiring to engage in the clinical use of radioactive isotopes shall establish an "Isotope Committee" to evaluate proposals for use of isotopes within the institution and to insure the proper use of the materials. This committee shall include:

- (1) A physician trained in internal medicine.
- (2) A physician trained in hematology (clinical pathologist).
- (3) A physician trained in therapeutic radiology.
- (4) A radiation physicist or other expert qualified in assay of radiomaterial and protective measures related to their use.

Local isotope committees of other naval activities engaged in the nonhuman use of radioisotopes should include one radiological medical officer, industrial hygienist or similar individual qualified in radiological protective measures.

### 7-3 STAFF

It is necessary that at least one medical officer have had special training or experience in the techniques of employing radioactive isotopes, and at least one hospitalman assigned to this program should be a qualified radioactive isotope technician. (See BuMed C/L 49-166 of 15 December 1949.)

### 7-4 SPECIAL LABORATORY AND WARD SPACE REQUIREMENTS

It is necessary to set aside laboratory space for exclusive use in handling and storing radioisotopes. Similarly, a ward or rooms must be set aside for the exclusive use of patients undergoing treatment or investigation.

### 7-5 SPECIAL EQUIPMENT

It is necessary to have on hand proper instruments for radio-assay of the isotopes and for monitoring the areas in which the radioactive materials are used and stored. The particular type of instrument employed will be dependent upon the isotopes used.

### 7-6 PROCUREMENT OF ISOTOPES

Procurement and authority for the therapeutic and clinical investigative use of radioactive isotopes will be coordinated by BuMed, Code 74. Installations desiring to use isotopes may obtain an initial supply of Atomic Energy Commission forms and other necessary information from BuMed, Code 74.

### 7-7 PROCUREMENT OF BUREAU APPROVAL

Medical activities desiring to engage in the use of radioactive isotopes should forward a list of proposed Isotope Committee members with their qualifications to BuMed, Code 74, via Code 31, for evaluation and approval. If the request is approved BuMed, Code 74, will forward instructions relative to the initial steps to be taken in the procurement of the special equipment required in this program, the assignment of a radioisotope technician

and for obtaining special training of a clinical staff member in the use of radioactive isotopes. The presence of a member of the clinical staff specially trained in the use of radioactive isotopes is not essential for the submission of the request, but if there is none present a member should indicate his desire to receive such training.

#### 7-8 CLINICAL REPORTS

Brief reports shall be submitted to BuMed, Code 74, at quarterly intervals, summarizing the experience of the staff in the therapeutic and clinical investigative use of radioactive isotopes, results obtained and recommendations of the local staff and/or Isotope Committee on any phase of the over-all program.

## Chapter 8. RADIOLOGICAL DEFENSE STAFF

### 8-1 GENERAL

(1) Billets.--The Radiological Defense Staff shall consist of the personnel of a particular activity filling the Radiological Defense billets authorized in NavPers 15822, 1950.

(2) Radiological Safety Committee.--The commanding officer of each activity engaged in the use of radioactive materials shall appoint a local Radiological Safety Committee whose duties shall include:

(a) The formulation of local radiological safety rules applicable to the routine laboratory procedures involving the handling, storage, and use of radioactive materials.

(b) The formulation of Station Orders for coping with accidents including spills or fires where sufficient radioactive materials are involved to constitute serious health hazard. The salient features of these orders shall include the protection of the health of personnel through rigid limitation of contamination, prompt and thorough decontamination, and the provision of adequate protective devices as indicated in various possible situations which might arise.

(c) To keep the commanding officer advised of the adequacy of local regulations and orders, as well as the supervision of those phases of work involving radiological health hazards.

(d) To coordinate the local radiological safety program with the radiological defense program and other special programs and bills. Radiological Defense Staff personnel shall be included on the local Radiological Safety Committee.

### 8-2 OPERATIONAL CLEARANCE

Operational clearance implies that radioactive contamination exists and special operating procedures are required. The commanding officer of the activity concerned upon the advice of his Radiological Defense Staff, is responsible for authorizing operational clearance.

### 8-3 FINAL CLEARANCE

Following completion of decontamination of an area the commanding officer of the activity concerned, upon the advice of his Radiological Defense Staff, shall authorize final clearance for that particular area. This shall apply, also, to final clearance on the decontamination of all forms of equipment, instruments, furniture, laundry, and personal items as well as personal decontamination. Final clearance shall imply that the area or object concerned has been monitored and found to have no point exceeding 0.015 r/24 hr beta plus gamma and no detectable alpha emitting isotopes.

The Radiological Medical Officer shall be responsible to the commanding officer for personnel decontamination and the Radiological Safety Officer shall be responsible to the commanding officer for area decontamination.

### 8-4 ALPHA CONTAMINATION

Access to an area contaminated with an alpha emitting substance requires specific clearance by the commanding officer after careful evaluation of the ingestion and inhalation hazard by the Radiological Defense

Staff. Fixed surface contamination giving a maximum reading of less than 500 counts/min-

ute/150 sq. cm. above background is generally considered to be within MPE limits.

## Chapter 9. STORAGE AND TRANSPORTATION OF RADIOACTIVE MATERIALS

### 9-1 STORAGE, HANDLING, AND TRANSPORTATION OF RADIOACTIVE MATERIALS

Storage, handling, and transportation of radioactive materials involves very serious and insidious health hazards and must be subject to regulation so that personnel will not be exposed to any radiation in excess of the pertinent MPE level. In addition, appropriate measures must be taken to prevent the occurrence of toxicological and internal radiation hazards resulting from inhalation, ingestion, or absorption of radioactive materials through open lesions.

9-2 When radioactive materials are shipped public health hazards are involved and must be adequately cared for. Therefore the provisions of Docket #3666 Interstate Commerce Commission, "In the Matter of Regulations for Transportation of Explosives and Other Dangerous Articles" in amendment of Section 233 of the Criminal Code (Transportation of Explosives Act), and Part II of the Interstate Commerce Act shall apply for shipping of radioactive materials (Appendix A). Also, any future pertinent revisions or amendments shall apply as soon as effective.

## Chapter 10. WASTE DISPOSAL

10-1 Radioisotopes may be discharged into main sewers in small amounts and with proper dilution provided the Atomic Energy Commission recommendations and the recommendations of the National Committee on Radiation Protection are not exceeded. In particular, amounts of  $I^{131}$  may be discharged in small increments totalling 10 millicuries per day in institutions or systems having a dry weather flow of 1 million gallons per day at the treatment plants. In amounts greater than 10 millicuries per day, the disposal should be through either a constant head orifice device or a constant drip discharge bottle. Using a uniform discharge device, 100 millicuries of these isotopes may be discharged in a 6-hour daylight period into a system having the above daily average dry weather flow. Permissible dosages for other sewage flows will be proportional and all limits are subject to revision at a particular activity on the basis of actual radioactive measurements in the sludges.

10-2 Radioactive phosphorus may be discharged into the sewer in the same quantities and by the same procedures as radioactive iodine. In the diagnostic and therapeutic use of  $P^{32}$  as well as the diagnostic use of  $I^{131}$  and the treatment of hyperthyroidism with  $I^{131}$  patients may use the toilet without any instructions.

10-3 Radioactive carbon may be discharged into the air as  $C^{14}O_2$  in concentrations equal to or less than  $10^{-6}$  microcurie/cc. of air.  $C^{14}$  in the form of particulate matter should not be discharged into the air.

10-4 Other radioactive wastes that emit beta and/or gamma radiation may be buried in the earth to a depth of 5 feet or more in a suitable, selected area which is in possession of and will be maintained by the user or a contracting agency provided they are diluted with stable isotopes of the same chemical element and in the same chemical form to the extent that 4.15 ergs are dissipated/gram of the element/day. This corresponds to 44 millireps assuming that the rep is that amount of radiation absorbed in tissue to the extent of 93 ergs/gram of tissue.

Alpha emitting waste material will be buried in accordance with the procedures of the Atomic Energy Commission. In general, sealed, watertight, metal drums containing the alpha waste will be buried imbedded in concrete at least 5 feet from the surface of the ground and away from possible drainage to any water supply.

In general, dumping at sea in properly sealed containers may be substituted for burial, provided it is done at least 200 miles from shore and in relatively unfrequented lanes of traffic.

## Chapter II. SAFETY INDOCTRINATION

11-1 In order that personnel working in a radioactive area may be properly informed as to the hazards and the safety measures to be observed, it is necessary that initial and continued indoctrination be provided. It

is particularly important that those in immediate charge of working parties be cognizant of their specific responsibilities in regard to the supervision and execution of safety measures.

## Chapter 12. SUMMARY OF MPE's

### 12-1 EXTERNAL RADIATION

#### (1) Total body exposure

0.3 r (0.3 rep) integrated over a period of a week obtained in a single or accumulated dose. 0.05 r (0.05 rep) or less/24 hours for routine operations. Integrated exposures greater than 0.3 r per week require removal from further exposure until "Recovery" can be effected using 1 week as the time index of exposure.

#### (2) Local external

1.0 r/week for beta exposure to the hands.

(3) Individuals working with external radiation for a short period not to exceed 2 years

1.25 r/month--single exposure allowable if no further exposure that month.

(4) Particle accelerators and neutron exposures

Special tolerance consideration not in scope of publication.

#### (5) Fires and emergency spills

Not to exceed 5 r single exposure and 15 r per year.

### 12-2 INTERNAL RADIATION

#### (1) Plutonium or heavy alpha emitters

$5 \times 10^{-12}$  microcurie/cc. of air for continuous exposure for 1 year.

Plutonium

0.5 microgram within the body.

Radium

0.1 microgram within the body.

Radon

$10^{-12}$  curie/liter exhaled air.  $5 \times 10^{-13}$  curie/liter exhaled air (preemployment).

(2) Air contamination by more hazardous beta/gamma emitters

$10^{-9}$  microcurie/cc. air. General rule is to wear masks when content exceeds  $10^{-9}$  microcurie/cc. air and to evacuate area where air content exceeds  $10^{-8}$  microcurie per cc. air.

(3) Air contamination--alpha  
Radon

$5 \times 10^{-12}$  microcurie/cc. air.  
 $10^{-11}$  curie/liter.

(4) Food and water contamination

$10^{-7}$  microcurie/cc.

### 12-3 PHYSICAL REQUIREMENTS

(1) General physical requirements are the same as required for active duty in the military service.

(2) In addition to the general physical requirements, the following findings are considered disqualifying for work entailing passive exposure to ionizing radiation:

All exposed wounds, whether cuts, abrasions, or ulcerations (except when working with sealed sources or x-ray).

Total white count below 4,000 or above 12,000 (in cases where abnormal white cell count may be due to transient diseases or other conditions, reexamination should be made upon recovery).

### 12-4 PROTECTIVE DEVICES

(1) Dosage measurement.

(2) Respirators

Persistently abnormal differential count.

Total red blood cell count below 3.5 million or above 6.5 million.

A radon concentration of  $5 \times 10^{-13}$  curie/liter or greater in exhaled air, taking into account the radon concentration of the surrounding atmosphere (indicative of a deposition of more than 0.05 microgram of radium in the body).

Any evidence of previous radiation injury which is considered disqualifying by the medical examiner.

Film badges worn by all in radioactive areas, pocket dosimeters if danger of exceeding tolerance.

Areas with adequate oxygen and no toxic fumes or gases:

Army Assault Mask with M-11, E-12, or M-10-A1 cannister; Navy Combat Mask, MK-IV, B-2 cannister.

Areas with oxygen deficiency or where noxious gases exist:

Rescue breathing apparatus.

Positive pressure mask.

Mask with self-contained air or oxygen supply

### 12-5 WASTE DISPOSAL

(1) Iodine-<sup>131</sup>

Ten millicuries per day with dry weather flow of  $10^6$  gal/day at treatment plants. Constant head orifice or constant drip discharge bottle used for 10-100 millicuries in 6-hour daylight period. No toilet instructions in treatment of hyperthyroidism or any diagnostic use.

(2) Phosphorus<sup>32</sup>

Same as I<sup>131</sup> except toilet instructions need not be given to patients for any diagnostic or therapeutic use of P<sup>32</sup>.

(3) Carbon <sup>14</sup>

<sup>14</sup>C can be discharged into the air as <sup>14</sup>O<sub>2</sub> in concentrations equal to or less than 10<sup>-6</sup> microcurie per cc. of air.

#### 12-6 BURIAL

(1) Beta and/or gamma.

Radioisotopes that emit beta and/or gamma radiation may be buried in the earth to a depth of 5 feet or more in a suitable, selected area which is in the possession of and will be maintained by the user or contracting agency, provided they are diluted with stable isotopes of the same chemical element in the same chemical form to the extent that 4.15 ergs are dissipated per gram of element per day.

(2) Alpha.

In accordance with the procedures of the Atomic Energy Commission.

(3) Burial at sea, 200 miles from shore and in least frequented areas may be substituted for above.

#### 12-7 CLEARANCES

(1) Operational.

Implies that contamination exists and special operating procedures are required. Clearance granted by commanding officer on technical advice of Radiological Defense Staff members. In peacetime 0.3 r/week ordinarily will not be exceeded except for operational necessity. Fixed alpha contamination less than 500 counts per minute per 150 sq. cm. of area.

(2) Final.

Also granted by the commanding officer. No point greater than 0.015 r/24 hours beta and gamma and no detectable alpha.

## **Appendix A**

# **FEDERAL RULES AND REGULATIONS ON TRANSPORTATION OF RADIOACTIVE MATERIALS**

- 1. PERTINENT INTERSTATE COMMERCE COMMISSION  
REGULATIONS**
- 2. TRANSPORTATION BY AIR OF RADIOACTIVE  
MATERIALS**  
**(Regulations of the Civil Aeronautics Board)**
- 3. POSTAL MAILING OF RADIOACTIVE MATERIALS**

# Title 49. TRANSPORTATION AND RAILROADS

## Chapter I. INTERSTATE COMMERCE COMMISSION

### Subchapter A. General Rules and Regulations

#### Parts 71-85. TRANSPORTATION OF EXPLOSIVES<sup>1</sup>

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#### Miscellaneous Amendments

Docket No. 3666

#### IN THE MATTER OF REGULATIONS FOR TRANSPORTATION OF EXPLOSIVES AND OTHER DANGEROUS ARTICLES

At a session of the Interstate Commerce Commission, Division 3, held at its office in Washington, D. C., on the 24th day of October A. D. 1947.

It appearing, that pursuant to section 233 of the Transportation of Explosives Act approved March 4, 1921, (41 Stat. 1445), and Part II of the Interstate Commerce Act, the Commission has formulated and published certain regulations for transportation of explosives and other dangerous articles.

It further appearing, that in applications received we are asked to amend the aforesaid regulations as set forth in provisions made part thereof.

It is ordered, that the aforesaid regulations for transportation of explosives and other dangerous articles be, and hereby, amended as follows:

(Pertinent amendments included up to 28 April 1950)

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<sup>1</sup> Parts 2, 3, 4, 5, and 7, in this order appear in CFR as Parts 73, 75, 72, 80, 81, and 85.

PART 2 - LIST OF EXPLOSIVES AND  
OTHER DANGEROUS ARTICLES  
(CFR 73)

Amending commodity list, section 4, order  
August 16, 1940, as follows:

Article	Classed	Exemptions and packing (See sec.)	Label required if not exempt	Maximum quantity in one outside con- tainer by rail ex- press
(Add) Radioactive Poison	D	367, 368	Poison Radio- active mate- rials (Blue or Red)	2,000 millicuries (See sec. 366 (c))

PART 3 - REGULATIONS APPLYING TO  
SHIPPERS (CFR 75)

Amending order August 16, 1940, as follows:

(ADD) 16A UNITED STATES ATOMIC ENERGY  
COMMISSION SHIPMENTS

Shipments of radioactive materials, made  
by the Atomic Energy Commission, or under  
its direction or supervision, which are  
escorted by personnel especially designated  
by the Atomic Energy Commission, are exempt  
from these regulations.

Superseding and amending par. (a), sec. 29  
(Empty containers), order March 29, 1944,  
to read as follows:

(Add) (a) (1) All containers and accessories  
which have been used for shipments of radio-  
active materials when shipped as empty must  
be sufficiently free of radioactive contamina-  
tion so as to conform to the conditions of  
paragraph (a), subparagraphs 1, 2, and 3, of  
section 367.

Amending order August 16, 1940, as follows:

(Add) 73.366 RADIOACTIVE MATERIALS  
CLASS D POISON  
RADIOACTIVE MATERIALS LABEL

(a) Radioactive material is any material  
or combination of materials that spontaneously  
emits ionizing radiation. For the purpose

of these regulations radioactive materials  
are divided into three groups according to  
the type of rays emitted at any time during  
transportation, as follows:

(1) Group I - Radioactive materials  
that emit gamma rays only or both gamma  
and electrically charged corpuscular rays.

(2) Group II-Radioactive materials  
that emit neutrons and either or both the types  
of radiation characteristic of Group I mate-  
rials.

(3) Group III-Radioactive materials  
that emit electrically charged corpuscular  
rays only, i.e., alpha or beta, etc., or any  
other that is so shielded that the gamma  
radiation at the surface of the package does  
not exceed 10 milliroentgens for 24 hours at  
any time during transportation. (As amended  
28 April 1950.)

(b) Radioactive materials must not be  
offered for transportation via rail freight  
except as specifically provided in section 367,  
or except by special arrangements and under  
conditions approved by the Bureau of Ex-  
plosives.

(c) Not more than 2,000 millicuries of  
radium, polonium, or other members of the  
radium family of elements, and not more than  
that amount of any other radioactive sub-  
stance which disintegrates at the rate of

NOTE.--For purposes of these regulations  
1 millicurie is that amount of any radioactive  
material which disintegrates at the rate of 37  
million atoms per second.

100,000 million (10<sup>11</sup>) atoms per second may be packed in one outside container for shipment via rail express, except by special arrangements and under conditions approved by the Bureau of Explosives.

(Add) 73.367

(a) Radioactive materials are exempt from prescribed packing, marking, and labeling requirements provided they fulfill all of the following conditions:

(1) The package must be such that there can be no leakage of radioactive material under conditions normally incident to transportation.

(2) The package must contain not more than 0.1 millicurie of radium, or polonium, or that amount of strontium 89, strontium 90, or barium 140 which disintegrates at a rate of 5 million atoms per second, or that amount of any other radioactive substance which disintegrates at a rate of 50 million atoms per second.

(3) The package must be such that no significant alpha, beta, or neutron radiation is emitted from the exterior of the package and the gamma radiation at any surface of the package must be less than 10 milliroentgens for 24 hours.

(b) Manufactured articles other than liquids such as instrument or clock dials of which radioactive materials are a component part, and luminous compounds, when securely packed in strong outside containers are exempt from specification packing, marking, and labeling requirements provided the gamma radiation at any surface of the package is less than 10 milliroentgens in 24 hours.

(c) Radioactive materials such as ores, residues, et cetera, of low activity packed in strong tight containers are exempt from specification packing and labeling requirements for shipment in carload lots by rail freight provided the gamma radiation or equivalent will not exceed 10 milliroentgens per hour at a distance of 12 feet from any surface of the car, and that the gamma radiation or equivalent will not exceed 10 milliroentgens per hour at a distance of 5 feet from either end surface of the car. (As

amended 19 October 1948.) There must be no loose radioactive material in the car, and the shipment must be braced so as to prevent leakage or shift of lading under conditions normally incident to transportation. The car must be placarded by the shipper as provided in Section 541A and 552 of these regulations. Shipments must be loaded by consignor and unloaded by consignee.

#### PACKING AND SHIELDING

(Add) 73.368

(a) Radioactive materials that present special hazards due to their tendency to remain fixed in the human body for long periods of time (i.e., radium, plutonium, and radioactive strontium, etc.) must, in addition to the packing hereinafter prescribed, be packed in inside metal containers specification 2R, or other container approved by the Bureau of Explosives.

(b) All radioactive materials must be so packed and shielded that the degree of fogging of undeveloped film under conditions normally incident to transportation (24 hours at 15 feet from the package) will not exceed that produced by 11.5 milliroentgens of penetrating gamma rays of radium filtered by  $\frac{1}{2}$  inch of lead.

(c) The design and preparation of the package must be such that there will be no significant radioactive surface contamination of any part of the container.

(d) The smallest dimension of any outside shipping container for radioactive materials must be not less than 4 inches.

(e) All outside shipping containers must be of such design that the gamma radiation will not exceed 200 milliroentgens per hour or equivalent at any point of readily accessible surface. Containers must be equipped with handles and protective devices when necessary in order to satisfy this requirement.

(f) The outside shipping container for any radioactive material unless specifically exempt by s. 73.367 must be a wooden box specification 15A or 15B, fiber drum specification 21A, or a fiberboard box specification

12B, except that equally efficient containers may be used when approved by the Bureau of Explosives. (As amended 7 March 1949.)

(g) Radioactive materials Group I, liquid, solid, or gaseous, must be packed in suitable inside containers completely surrounded by a shield of lead or other suitable material of such thickness that at any time during transportation the gamma radiation at 1 meter (39.3 inches) from any point on the radioactive source will not exceed 10 milliroentgens per hour. The shield must be so designed that it will not open or break under conditions incident to transportation. The minimum shielding must be sufficient to prevent the escape of any primary corpuscular radiation to the exterior of the outside shipping container.

(h) (1) Radioactive materials Group II, liquid, solid, or gaseous, must be packed in suitable inside containers completely shielded so that at any time during transportation the radiation measured at right angles to any point on the long axis of the shipping container will not exceed the following limits:-

(a) Gamma radiation of 10 mrhm.

(b) Electrically charged corpuscular radiation which is the physical equivalent\* of 10 mrhm. of gamma radiation.

(c) Neutron radiation which is the physical equivalent\* of 2 mrhm. of gamma radiation.

(d) If more than one of the types of radiation named in paragraphs (a), (b), and/or (c) is present the radiation of each type must be reduced by shielding so that the total does not exceed the equivalent of paragraphs (a), (b), or (c).

(h) (2) The shielding must be designed so as to maintain its efficiency under conditions normally incident to transportation

\*For purposes of these regulations the "physical equivalent" of a roentgen is that amount of radiation that would be absorbed in tissue to the extent of 83 ergs per gram. (mrhm. is an abbreviation for milliroentgens per hour at 1 meter (39.3 inches).)

and must provide personnel protection against fast or slow neutrons and all other ionizing radiation originating in the radioactive materials or any part of the aggregate constituting the complete package.

(i) Liquid radioactive materials Groups I, II, or III must, in addition, be packed in tight glass, earthenware, or other suitable inside containers. The inside containers must be surrounded on all sides and within the shield by an absorbent material sufficient to absorb the entire liquid contents and of such nature that its efficiency will not be impaired by chemical reaction with the contents. If the container is packed in a metal container specification 2R, or other container approved by the Bureau of Explosives, the absorbent cushioning is not required.

(j) Radioactive materials Group III, liquid, solid, or gaseous, must be packed in suitable inside containers completely wrapped and/or shielded with such material as will prevent the escape of primary corpuscular radiation to the exterior of the shipping container, and secondary radiation at the surface of the container must not exceed 10 milliroentgens per 24 hours, at any time during transportation. (As amended 7 March 1949.)

Superseding and amending paragraph (h), section 402. (Poison label) Order August 16, 1940, to read as follows:

(Add)

(h) (1) "Radioactive Materials" label as described in section 404 (t) on containers of Class D Poisons, Group I and II except when exempted by section 367.

(Add)

(h) (2) "Radioactive Materials" label as described in section 404 (u) on containers of Class D Poisons, Group III, except when exempted by section 367.

NOTE.--In determining compliance with requirements of paragraphs (e), (g), (h), and (j) measurements of radiation must be made with a Landsverk-Wollen Electrometer Model L-100 or equally efficient standardized meter.

73.369 (a) Each outside container of radioactive material Group I or II, unless exempt

by section 73.367, must be labeled with a properly executed label as shown below:

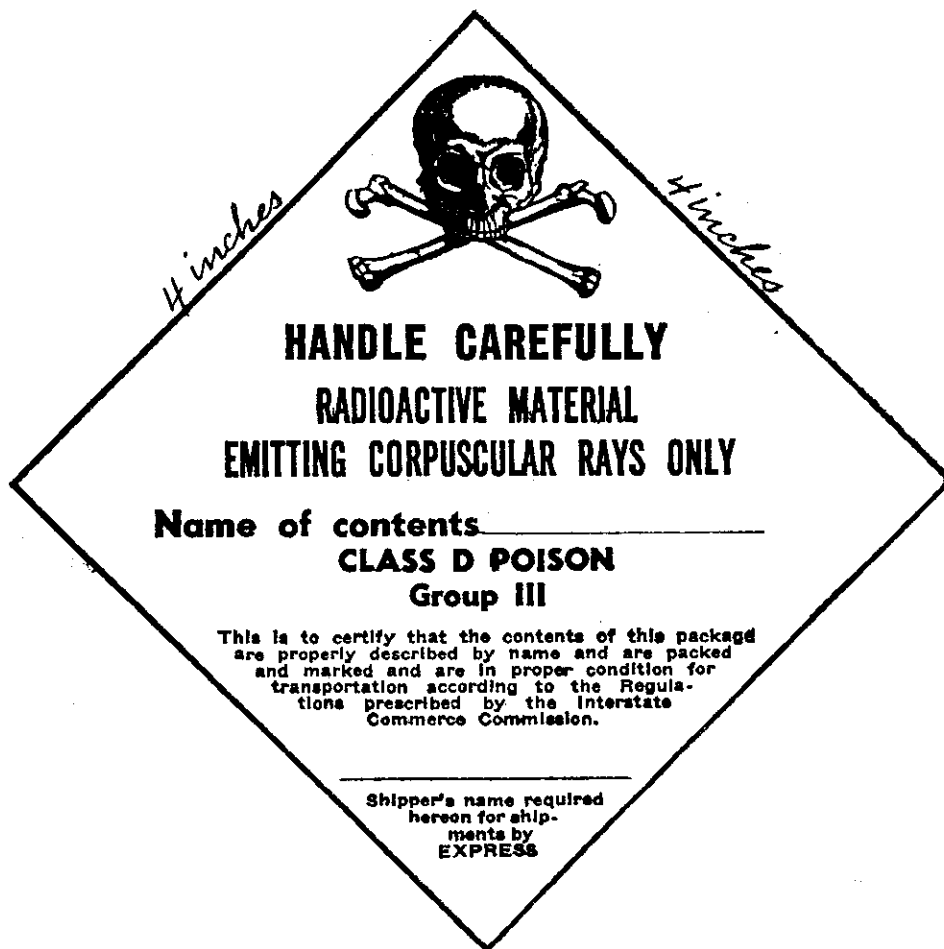
Radioactive Materials Label  
(Red printing on white)



73.369 (b) Each outside container of radioactive material Group III must unless ex-

empt by section 73.367, be labeled with a properly executed label as shown below:

Radioactive Material Label  
(Blue printing on white)



PART 4 - REGULATIONS APPLYING PARTICULARLY TO CARRIERS BY RAIL FREIGHT (CFR 80)

Amending section 532 (Loading packages of other dangerous articles into cars), order August 16, 1940, as follows:

(Add)

(j) RADIOACTIVE ORES: RESIDUES: AND SIMILAR MATERIAL

(j) (1) Shipments of radioactive ores, residues, or similar material as provided in section 367 must be so loaded as to avoid spillage and scattering of loose material.

(j) (2) The amount of radioactive material loaded in a car must be limited as provided in section 367.

(j) (3) No persons shall remain in a car containing radioactive material unnecessarily and the shipper must furnish the carrier with such information and equipment as is necessary for the protection of the carrier's employees.

(j) (4) Any loose radioactive material must be removed from the car, placed in a

closed container in a segregated location and held for instructions from the shipper or the Bureau of Explosives.

Amending headline and sideline descriptions of section 533 (Loading and storage chart), order August 16, 1940, by adding column 14, as follows:

(Add)

Radioactive materials (Class D poisons)

(Add)

"X" to columns a, b, c, d, e, f, and g, both horizontally and perpendicularly opposite entry "radioactive materials (Class D poisons)."

Amending order August 16, 1940, (Placards on cars), as follows:

(Add)

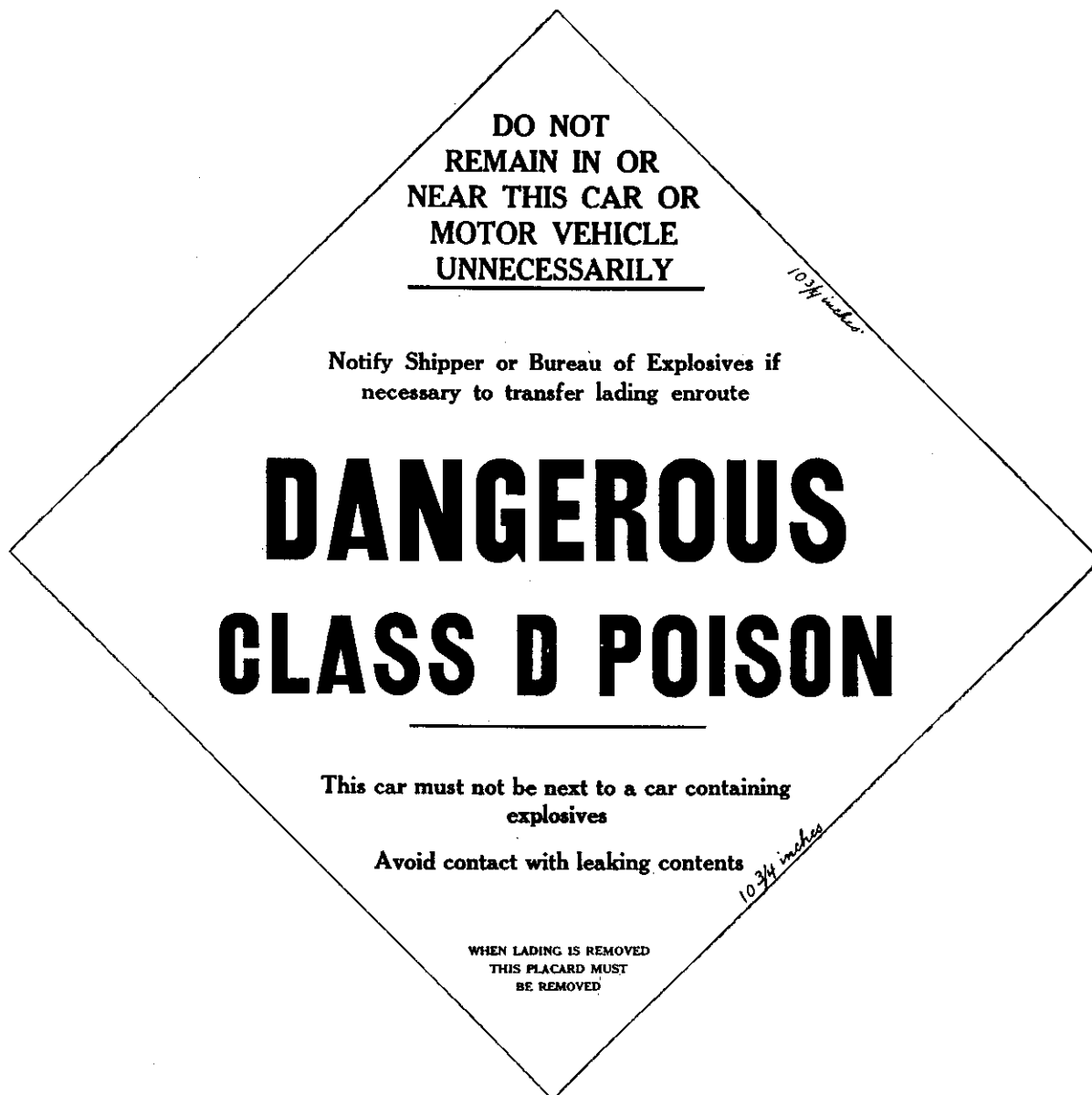
541A DANGEROUS placards as prescribed in section 552 must be applied to cars containing shipments of Class D poisons as provided in section 366 and 367 of these regulations.

(Add)

552 The "Dangerous" placard for Class D poisons must be of a diamond shape meas-

uring 10-3/4 inches on each side, and must bear the work in red letters as shown in the following cut:

Dangerous Placard for Class D Poisons  
(Reduced size)



Amending section 589 (Handling cars), order February 12, 1947, as follows:

POSITION IN TRAIN OF CARS CONTAINING  
CLASS D POISON

(Add)

(k) (1) In a freight train or mixed train either standing or during transportation thereof, a car placarded "Dangerous-Class D Poison" must not be handled next to cars placarded "Explosives" or next to carload shipments of undeveloped film.

Amending order August 16, 1940, as follows:

(Add) 597A Class D Poisons

(a) In event of breakage of container, wreck, fire, or unusual delay involving cars placarded "Dangerous--Class D Poison" as prescribed in section 541A the car and any loose radioactive material must be isolated as far as possible from danger of human contact and no persons must be allowed to remain close to the car or contents needlessly until qualified persons are available to supervise handling. The shipper and the Bureau of Explosives should be notified immediately.

(b) Cars, buildings, areas, or equipment in which Class D Poisons have been spilled must not be again placed in service or occupied until decontaminated by qualified persons.

Add

(j) (4)

TABLE

Total number of units	Minimum distance in feet to nearest undeveloped film	Distance in feet to area that may be continuously occupied by passengers or employees	Distance in feet from dividing partition of a combination car
1 to 10	15	3	3
11 to 20	20	4	4
21 to 30	25	5	5
31 to 40	30	6	6

Note 1.--The distance in the table must be measured from the nearest point of the radioactive container or containers.

Note 2.--1 unit equals 1 milliroentgen per hour 1 meter for hard gamma radiation or the amount of radiation which has the same effect on film as 1 mrhm. of hard gamma rays of radium filtered by one-half inch of lead.

PART 5 - REGULATIONS APPLYING TO  
CARRIERS BY RAIL EXPRESS  
(CFR 81)

Amending section 655 (Handling packages), order November 8, 1941, as follows:

(Add)

(j) (1) A container of radioactive material bearing red label must not be placed in cars, depots, or other places closer than 3 feet to an area which may be continuously occupied by passengers, employees, or shipments of animals. When more than one such container is present, the distance from occupied areas must be computed from the table in paragraph (j) (4) by adding the number of units shown on labels on the containers.

(Add)

(j) (2) In a combination car carrying passengers and/or express shipments, a container of radioactive material must not be placed closer than 3 feet to the dividing partition. For more than one such container the distance must be computed by method described in paragraph (j) (4).

(Add)

(j) (3) A container of radioactive material, red label, must not be placed closer than 15 feet to any package containing undeveloped film. If more than one such con-

tainer is present the distance must be computed from the table in paragraph (j) (4) by adding the number of units shown on the labels on the packages.

(Add)

(j) (5) Not more than 40 units of radioactive material (red label) shall be transported in any car or stored in a depot at one time.

(Add)

(j) (6) All containers of radioactive material (red label) must be carried by the handles when handles are provided.

(Add)

(j) (7) Radioactive materials (Class D Poisons) must not be loaded in the same car with samples of explosives.

(Add)

(j) (8) If for any reason, a package containing radioactive material (red label) would otherwise remain in the same building for a period longer than 24 hours, it must be moved to a different location after each 24 hours.

(Add)

(j) (9) In case of fire, wreck, breakage, or unusual delay involving any shipment of radioactive material the package or material should be segregated as far as possible from human contact. The shipper and the Bureau of Explosives should be immediately notified. In case of breakage of a package containing radioactive material and when it appears likely that the inside container may have been damaged, great care must be exercised to prevent contact with, inhalation or any other means of the radioactive material entering the body.

#### APPENDIX TO PART 3 - SHIPPING CONTAINER SPECIFICATIONS (CFR 72)

Amending order August 16, 1940, as follows:

(Add) Specification 2R

Inside Containers - METAL TUBES

1. Size - Outside diameter of the tube must not exceed 3 inches and length must not exceed 8 inches exclusive of flanges, or handling, or fastening devices.

2. Manufacture - Stainless steel, malleable iron, or brass having a wall thickness of not less than 3/32 inch for diameter up to 2 inches and not less than 1/8 inch for diameter up to 3 inches. The ends of the tube must be fitted with screw type closures except that one end of the tube may be permanently closed by a weld or brazed plate. Welded or brazed side seams are authorized.

3. Welding and Brazing must be done in a workmanlike manner and must be free from defects.

4. Closing devices must be of screw type. Number of threads per inch must be not less than United States Standard pipe threads. Caps or plugs are authorized.

#### PART 7 - REGULATIONS APPLYING TO SHIPMENT MADE BY WAY OF COMMON, CONTRACT, OR PRIVATE CARRIERS BY PUBLIC HIGHWAY (CFR 85).

Superseding and amending paragraph (a), section 815 (Labels), order November 8, 1941, to read as follows:

(a) Labels (Section 404 (e) to (u) for description of labels).--Labels prescribed by the Commission's regulations, Part 3, must have been applied to shipments, unless exempt from these regulations, and in addition the shipper must have certified to compliance with the regulations by writing, stamping, or printing his name underneath the certificate printed thereon or on the shipping papers.

Superseding and amending paragraph (a), section 823 (Marking on motor vehicles), order November 8, 1941, to read as follows:

(a) Marking on motor vehicles and trailers other than tank motor vehicles.--Every motor vehicle transporting any quantity of dangerous explosives Class A, poison gas Class A, or radioactive material, poison Class D re-

quiring red radioactive materials label, and every motor vehicle transporting 2,500 pounds or more of explosives, Class B, inflammable liquids, corrosive liquids, compressed gas and tear gas, or 5,000 pounds or more of two or more articles of these groups shall be marked or placarded on each side and rear with a placard or lettering in letters not less than 3 inches high on a contrasting background as follows:

Explosives, Class A	EXPLOSIVE 1
Explosives, Class B	DANGEROUS 1
Inflammable Liquid	DANGEROUS 1
Corrosive liquid	DANGEROUS 1
Compressed gas	COMPRESSED GAS 1
Poison gas, Class A	POISON GAS 1
Tear Gas	DANGEROUS 1
Dangerous, class D poison	DANGEROUS-RADIOACTIVE MATERIAL

1 No change in note

Amending section 824 (Loading and unloading), order November 8, 1941, as follows:

## Radioactive Material

(Add)

(i) (1) A container of radioactive material bearing red label must not be placed in vehicles, terminals, or other places closer than 3 feet to an area which may be continuously occupied by passengers, employees, or shipments of animals. When more than one such container is present, the distance from occupied areas must be computed from the table in paragraph (i) (3) by adding the number of units shown on labels on the containers.

(Add)

(i) (2) A container of radioactive material red label must not be placed closer than 15 feet to any package containing undeveloped film. If more than one such container is present the distance must be computed from the table in paragraph (i) (3) by adding the number of units shown on the labels on the packages.

(Add)

(i) (3)

TABLE

Total number of units	Minimum distance in feet to nearest undeveloped film	Distance in feet to area that may be continuously occupied by passengers or employees for periods:	
		Up to 8 hours	Exceeding 8 hours
1 to 10	15	3	5
11 to 20	20	4	7
21 to 30	25	5	9
31 to 40	30	6	10

Note 1.--The distance in the table must be measured from the nearest point of the radioactive container or containers.

Note 2.--1 unit equals 1 milliroentgen per hour at 1 meter for hard gamma radiation or the amount of radiation which has the same effect on film as 1 mrhm. of hard gamma rays of radium filtered by one-half inch of lead.

(Add)

(i) (4) Not more than 40 units of radioactive material (red label) shall be transported in any vehicle or stored in a terminal at one time. Packages must be so blocked or braced in vehicles as to prevent any shift of lading under conditions normally incident to transportation.

(Add)

(i) (5) All containers of radioactive material (red label) must be carried by the handles when handles are provided.

(Add)

(i) (6) Radioactive materials (Class D poisons) must not be loaded in the same vehicle with class A explosives.

(Add)

(i) (7) If for any reason, a package containing radioactive materials (red label) would otherwise remain in the same building for a period longer than 24 hours, it must be moved to a different location after each 24 hours.

Amending headline and sideline description of section 825 (Loading and storage chart), order November 8, 1941, by adding column 14, as follows:

(Add) Radioactive materials (Class D Poisons)

(Add) "X" in columns a, b, c, d, e, f, and g, both horizontally and perpendicularly opposite entry "radioactive materials (Class D poisons)."

Amending section 828 (Accidents etc.), order November 8, 1941, as follows:

Radioactive Materials - Poison D

(Add)

(g) In case of accident to vehicle resulting in breakage of, or unusual delay to any shipment of radioactive material the package or material should be segregated as far as possible from human contact. The shipper and the Bureau of Explosives should be imme-

diately notified. In case of breakage of a package containing radioactive material and when it appears likely that the inside containers may have been damaged, great care must be exercised to prevent contact with or inhalation of radioactive material by any person.

Amending section 850 - (Vehicles transporting passengers etc.), order November 8, 1941, as follows:

(Add)

(g) Radioactive materials on passenger-carrying vehicles.--No motor carrier may transport any radioactive material poison, Class D, requiring red or blue radioactive material label under these regulations in or on any bus while engaged in the transportation of passengers except where no other practicable means of transportation is available. Packages of radioactive materials must be handled and placed in the vehicle in accordance with the requirements of section 824 (i).

It is further ordered, that the aforesaid regulations as further amended therein shall be and remain in full force and effect on and after January 11, 1948, and shall be observed until further order of the Commission.

It is further ordered, that compliance with the aforesaid regulations, as amended, made effective by this order, is hereby authorized on and after day of service hereof.

And it is further ordered, that copies of this order be served upon all parties of record herein, and that notice shall be given to the general public by depositing a copy in the office of the Secretary of the Commission at Washington, D. C., and by filing it with the Director, Division of Federal Register.

Authority: 41, Stat. 1445, 49 Stat. 546, 52 Stat. 1237, 54 Stat. 921, 56 Stat. 176, 18 U. S. C. 383, 49 U. S. C. 304.

By the Commission, Division 3.

(SEAL)

W. P. BARTEL,  
SECRETARY

# TRANSPORTATION BY AIR OF RADIO- ACTIVE MATERIALS

## (Regulations of the Civil Aeronautics Board)

(Effective 20 July 1949)

Transportation of Explosives and other Dangerous Articles:

Part 49, as amended, authorizes the transportation of a limited number of items classified as "explosives or other dangerous articles." Since 1942 when regulations on this subject were originally promulgated, the need for rapid transportation of additional articles of such nature has rapidly accelerated. Experience has shown that many articles within this classification can be safely transported by air when appropriately packaged. In view of current information as to safe operating conditions and transportation needs, the Board has revised Part 49 in order to permit a greater number of articles

to be carried and to prescribe adequate marking, labeling, and packaging requirements. A more detailed explanation of the basis and purpose of the revised part is attached hereto.

For the reasons stated above the Board finds that the provisions of Part 49, as revised, are necessary to provide adequately for safety of flight in air commerce.

Interested persons have been afforded an opportunity to participate in the revision of this part, and due consideration has been given to all relevant matter presented.

In consideration of the foregoing the Civil Aeronautics Board hereby makes and promulgates a revision of Part 49 of the Civil Air Regulations (14 CFR, Part 49, as amended) effective July 20, 1949, to read as follows:

## TRANSPORTATION OF EXPLOSIVES AND OTHER DANGEROUS ARTICLES

### 49.0 APPLICABILITY OF PART

Explosives or other dangerous articles, including flammable liquids, flammable solids, oxidizing materials, corrosive liquids, compressed gases, and poisonous substances shall not be loaded in or transported by civil aircraft in the United States, or transported anywhere in air commerce in civil aircraft of United States registry except as hereinafter provided.

### 49.1 DEFINITIONS

(a) As used in this part the words listed below shall be defined as follows:

(1) Explosives.--Those liquids, gases, or solids specified as "Forbidden Explosives," Class A, Class B, or Class C explosives by the ICC Regulations.

(2) Flammable liquid.--A flammable liquid is any liquid which gives off flammable vapors (as determined by flash point from

Tagliabue's open-cup tester, as used for test of burning oils) at or below a temperature of 80°F.

(3) Flammable solid.--A flammable solid is a solid substance, other than one classified as an explosive, which is likely under conditions incident to transportation, to cause fires through friction, through absorption of moisture, through spontaneous chemical changes, or as a result of retained heat from the manufacturing or processing.

(4) Oxidizing material.--An oxidizing material is a substance such as a chlorate, permanganate, peroxide, or a nitrate, that yields oxygen readily to stimulate the combustion of organic matter.

(5) Corrosive liquids.--Corrosive liquids are those acids, alkaline caustic liquids, and other corrosive liquids which, when in contact with living tissue, will cause severe damage to such tissue by chemical action; or which, in case of leakage, will materially damage the aircraft structure or cargo; or which are likely to cause fire when in contact with organic matter or with certain chemicals.

(6) Compressed gas.--A compressed gas for the purposes of these regulations is defined as any material or mixture having in the container either an absolute pressure exceeding 40 pounds per square inch at 70°F., or an absolute pressure exceeding 104 pounds per square inch at 130°F., or both; or any liquid flammable material having a Reid vapor pressure exceeding 40 pounds per square inch absolute at 100°F. (See 49.1(a) (7) (i) for gases defined and classified as poisonous.)

(i) Any compressed gas, as defined above, shall be classified as a flammable compressed gas if either (1) a mixture of 13 percent or less (by volume) with air forms a flammable mixture or (2) the flammability range with air is greater than 12 percent regardless of the lower limit.

(7) Poisonous articles.--Poisonous articles for the purpose of these regulations are divided into four classes defined as follows:

(i) Extremely dangerous poisons--Class A.--Poisonous gases or liquids of such nature that a very small amount of gas, or

vapor of the liquid, mixed with air is dangerous to life. This class includes: chlorpicrin, cyanogen, diphosgene, ethyldichlorarsine, hydrocyanic acid, lewisite, methyldichlorarsine, mustard gas, nitrogen peroxide (tetroxide), phenylcarbylamine chloride, phosgene (diphosgene). (Dilute solutions of hydrocyanic acid of not exceeding 5 percent strength are classed as poisonous articles, (Class B).)

(ii) Less dangerous poisons--Class B.--Poisonous liquids and solids, including pastes and semisolids, are substances of such nature that they are chiefly dangerous by external contact with the body or by their being taken internally as in contaminated food or feeds.

(iii) Tear gas or irritating substances--Class C.--Tear gases are liquid or solid substances which upon contact with fire or when exposed to air give off dangerous or intensely irritating fumes, such as bromobenzylcyanide chloracetophenone, diphenylaminechlorarsine, and diphenylchlorarsine, but not including any poisonous article, Class A.

(iv) Radioactive materials--Class D.--A radioactive material is any material or combination of materials which spontaneously emits ionizing radiation. For the purpose of these rules, radioactive materials are divided into three groups, according to the type of radiation emitted at any time during transportation, as follows:

(I) Group I radioactive materials.--Group I radioactive materials are those materials which emit any gamma radiation, either alone or with electrically charged particles or corpuscles.

(II) Group II radioactive materials.--Group II radioactive materials are those materials which emit neutrons and either or both of the types of radiation characteristic of Group I radioactive materials.

(III) Group III radioactive materials.--Group III radioactive materials are those materials which emit only electrically charged particles or corpuscles (i.e. alpha and/or beta radiation).

(8) "Unit" of gamma radiation.--"Unit" of gamma radiation is one milliroentgen per hour at a meter for "hard

gamma" radiation, i.e., that amount of gamma radiation which will have the same effect on sensitive photographic film as one milliroentgen per hour at a meter of "hard gamma" radiation of radium filtered through one-half inch of lead.

(9) Passenger-carrying aircraft.--A passenger-carrying aircraft is an aircraft carrying any individual other than a flight crew or crew member, company employee, or an authorized government representative.

(10) Cargo aircraft.--A cargo aircraft is an aircraft other than a passenger-carrying aircraft which is carrying goods or property.

(11) Marking.--Marking is the display on the container of the name of the articles inside, as listed in the commodity list of the ICC Regulations.

(12) Labeling.--Labeling is the display on the container of an appropriate label as specified for a particular class of articles by the ICC Regulations.

(13) ICC Regulations.--ICC Regulations shall mean the "Interstate Commerce Commission's Regulations for Transportation of Explosives and Other Dangerous Articles.", effective January 7, 1941, as amended or revised from time to time.

(14) Aircraft operator.--An operator of aircraft shall include the owner, leasee, or any other person who causes or authorizes the operation of the aircraft.

#### 49.3 PACKING, MARKING, AND LABELING REQUIREMENTS

(a) Unless otherwise specifically provided in this part, explosives or other dangerous articles shipped by air shall be packed, marked, and labeled in accordance with the specifications established in Part 72 of the ICC Regulations for transportation by rail express: Provided, that liquids shall be packed only in containers which are securely closed, sufficient in strength to prevent any leakage or distortion of the containers caused by change in temperature or altitude during transit, and so filled as to provide adequate outage. All explosives or other dangerous articles shipped by air shall show the proper shipping name as shown in the commodity

list of Part 72 of the ICC Regulations and any instructions that are necessary for safe handling.

(b) No shipper shall offer and no air carrier or other operator of aircraft shall knowingly accept explosives or dangerous articles for carriage by air unless the shipper or his authorized agent has certified that the shipment complies with the requirements of this part. No shipment shall be accepted for transportation by passenger-carrying aircraft unless the package shows a clear and plainly visible statement that it is within the limitations prescribed for passenger operations. Any operator of aircraft may rely on such a certificate as prima-facie evidence that the shipment so certified complies with the requirements of this part.

#### PASSENGER-CARRYING AIRCRAFT

##### 49.10 ACCEPTABLE EXPLOSIVES AND OTHER DANGEROUS ARTICLES ON AIRCRAFT CARRYING PASSENGERS

No article listed in Appendices A or B of this part shall be carried on passenger-carrying aircraft, and no other explosive or dangerous article shall be carried in passenger-carrying aircraft except as provided in 49.11 through 49.18.

##### 49.18 RADIOACTIVE MATERIALS

Radioactive materials--Class D, Groups I, II, and III (liquid, solid, or gaseous) may be carried when packed, marked, and labeled in accordance with the provisions of 73.368 through 73.369 of the ICC Regulations. (See 49.55 for handling of radioactive materials in aircraft. See also 49.62 where certain other types of radioactive materials are exempted from certain of the requirements of this part.)

#### CARGO AIRCRAFT

##### 49.41 ARTICLES WHICH MAY BE CARRIED IN CARGO AIRCRAFT

In addition to the articles acceptable for transportation on aircraft carrying passengers, any article acceptable for and packed, marked,

and labeled in accordance with the ICC Regulations for transportation by rail express may be carried in cargo aircraft: Provided, that no article listed in Appendix A of this part shall be carried except under the provisions of 49.71. The maximum quantity in any one outside package or container shall not exceed that prescribed in the commodity list of Part 72 of the ICC Regulations.

#### LOADING AND HANDLING REQUIREMENTS

##### 49.51 CARGO LOCATION

(a) Articles subject to the requirements of this part shall not be carried in the cabins of passenger-carrying aircraft.

(b) Any article acceptable only for cargo aircraft shall be carried in accessible cargo pits or bins or in the cabin.

(c) Articles shall not be placed in the same cargo pit or bin nor placed side by side in cabins so that:

(1) Yellow label material is mixed with either white label or with red label material, or

(2) White label material is mixed with poison label material (red printing on white background).

##### 49.52 PILOT NOTIFICATION

When articles subject to the packing, marking, and labeling requirements of this part are carried on aircraft, the operator shall be responsible for notifying the pilot of the proper shipping name of the article as shown in the commodity list of Part 2 of the ICC Regulations, the type of label, quantity, and the location thereof. The pilot notification requirement may be met by entering the required information on the airplane load manifest.

##### 49.53 DAMAGED OR IMPROPERLY MARKED ARTICLES

If any package coming under the provisions of this part appears to be damaged, leaking, or improperly marked and labeled, it shall be removed from the aircraft and shall not be returned to transportation by air until it has been determined that the package and

its contents comply with the requirements of this part.

(a) In any instance where it is indicated that the requirements of this part have been violated, a report shall immediately be made to the nearest representative of the Administrator or Board.

##### 49.54 QUANTITY LIMITATIONS

Except as provided below not more than 50 pounds net weight of any articles subject to the packing and labeling provisions of this part may be carried in any one cargo pit or bin on passenger-carrying aircraft, or in any inaccessible cargo pit or bin on any aircraft:

(a) Not more than 150 pounds net weight of compressed noninflammable gas may be carried in any single cargo pit or bin on passenger-carrying aircraft or in any inaccessible cargo pit or bin in any aircraft.

(b) No quantity limit is prescribed for calcium hypochlorite, pyroxylin plastics, motion picture film, or radioactive material Group III.

(c) Not more than 40 units of radioactive material Groups I or II shall be carried on any aircraft.

(d) Except as provided above for inaccessible cargo pits or bins, no quantity limitations apply to the carriage of explosives or other dangerous articles under the provisions of this part in cargo aircraft.

##### 49.55 SPECIAL REQUIREMENTS FOR RADIOACTIVE MATERIALS

(a) Whenever any shipment of radioactive materials is damaged or appears to be damaged, it shall be removed from transportation and segregated as far as possible from human contact. The shipper shall immediately be contacted for disposal instructions, and the Administrator or the Board shall also be notified.

(b) Whenever there is any actual spillage of radioactive materials of such nature that the materials are no longer contained within their inner containers, no attempt shall be made to remove or clean up the materials until instructions are received from the ship-

per or other qualified persons, and then only when necessary protective measures have been taken, and qualified persons are present to supervise the handling.

(c) A container or groups of containers of radioactive materials shall not be placed closer than the distance specified in the distance table to any area that may be continuously occupied by crew members or passengers. If more than one such container is present the distance shall be computed from the table below by adding together the number of units shown on the label of each package.

Table for Personnel Separation

Total number of units*	Minimum distance to crew members and passengers (feet)**
0-2	1
3-5	2
6-10	3
11-20	4
21-30	5
31-40	6

\*Total number of units refers to the number found on the red label of a single package entered on the line reading, "Radiation Units from Package: No. \_\_\_\_." For two or more packages stored together, the total of the numbers of all such packages is meant.

\*\*Distance means the number of feet from the nearest edge of the nearest radioactive container.

(d) If any aircraft is engaged principally or entirely in the transportation of radioactive materials, it shall be the responsibility jointly of the shipper and the carrier to monitor all personnel involved so that the accepted limits of personnel radiation exposure are not exceeded.

#### EXEMPTED ARTICLES

##### 49.61 AIRCRAFT EQUIPMENT

Signaling devices, aviation fuel and oil carried in tanks complying with fuel and oil

tank installation provisions of the Civil Air Regulations, and other equipment and materials necessary for the safe operation of the aircraft on which they are carried shall be exempt from the provisions of this part.

##### 49.62 RADIOACTIVE MATERIALS

(a) Radioactive materials which meet all of the following conditions are exempt from packing, marking, and labeling requirements required by this part:

(1) The package shall be such that there can be no leakage of radioactive material under conditions normally incident to transportation.

(2) The package shall contain not more than 0.1 millicurie of radium, or polonium, or that amount of strontium 89, strontium 90, or barium 140 which disintegrates at a rate of 5 million atoms per second; or not more than that amount of any other radioactive substance which disintegrates at a rate of 50 million atoms per second.

(3) The package shall be such that no significant alpha, beta, or neutron radiation is emitted from the exterior of the package, and the gamma radiation at any surface of the package shall be less than 10 milliroentgens in 24 hours.

(b) Manufactured articles other than liquids, such as instrument or clock dials of which radioactive materials are a component part, and luminous compounds, when securely packed in strong outside containers are exempt from packing, marking, and labeling requirements, provided the gamma radiation at any surface of the package is less than 10 milliroentgens in 24 hours.

(c) (1) Radioactive materials such as ores, residues, etc., packed in strong, tight containers are exempt from packing and labeling requirements for shipment in plane-load lots, provided the per plane-load radiation intensity at 1 meter from any outside surface of the load (as loaded in place in the airplane) does not exceed 10 milliroentgens per hour of gamma radiation or equivalent. There shall be no loose radioactive material in the airplane, and the shipment must be braced and lashed so as to prevent leakage

or shift of lading under normal conditions of flight.

(2) It is the responsibility of the consignor and/or consignee to supervise, respectively, all loading and unloading operations and to monitor all personnel involved so that the accepted limits of personnel radiation exposure are not exceeded.

(d) Shipments of radioactive materials made by the Atomic Energy Commission or under its direction or supervision, which are escorted by personnel who are specially designated by the Atomic Energy Commission, are exempted from the provisions of these regulations where special arrangements are made with and approved by the Administrator.

#### 49.63 ADDITIONAL EXEMPTED ARTICLES

The following articles are exempted from the provisions of this part.

(a) Small arm ammunition.--Small arms ammunition in small quantities for personal use.

(b) Matches.--Small quantities of matches, of the strike-on-box, book, or card type, carried on the person.

(c) Pyroxylin plastics.--Articles manufactured from a pyroxylin plastic base such as hairbrushes, combs, and toothbrushes which are exempted from the requirements of the ICC Regulations.

(d) Safety film.--Film having an acetate base.

#### 49.71 SPECIAL AUTHORITY

In emergency situations or where other forms of transportation are impracticable, deviations from any of the provisions of this part for a particular flight may be authorized by the Administrator where he finds that the conditions under which the articles are to be carried are such as to permit the safe carriage of persons and cargo.

#### 49.81 PROHIBITED ARTICLES

No explosives or dangerous article listed in Part 72 of the ICC Regulations as an Explosive A, a Poison A, a forbidden article, or as an article not acceptable for rail express (see 49.62 for authorization of the carriage of certain radioactive materials), nor any

article listed in Appendix A shall be carried on aircraft subject to the provisions of this part.

#### EXPLANATORY STATEMENT OF PART 49

Present Part 49 provides for the transportation by air of certain articles commonly classified as explosives or dangerous articles. Since the carriage of explosives and other dangerous articles is seldom accomplished entirely by air transportation, but generally is combined with some form of surface transportation to bring the items to the aircraft and to take them away after the air lift, it was necessary that applicable Civil Air Regulations governing the transportation of such cargo be coordinated with the Interstate Commerce Commission Regulations which regulate the carriage of such articles by the principal surface carriers. Thus, in promulgating Part 49 in 1945, the Board adopted the various classifications of dangerous articles and the packaging and labeling requirements of the pertinent Interstate Commerce Commission Regulations as effective January 7, 1941.

The selection in 1945 of a few specific items for inclusion in Part 49 as articles acceptable for carriage was based on two criteria. The first of these was that the acceptable items had to be relatively innocuous and had to be safely transportable in aircraft as determined from the technical information then available to the Board. Second, there had to be a demonstrable need for carriage of the particular article. It was believed by the Board that the experience of aircraft operators under Part 49 together with advances of technology would lead to an enlarged list of acceptable materials. The judgment of the Board has been borne out. Experience under the 1945 rule had been excellent. The operators have acquired techniques of handling the articles covered by Part 49 and have demonstrated their fitness to handle a greater variety of such materials. At the same time the rapid development of the air cargo industry has brought to light a need for the inclusion of a greater variety of articles falling into the so-called dangerous

category. It is evident, therefore, that a revision of the present Part 49 is in order.

In determining what additional items may be safely transported by air, staff members of the Board have consulted with the Bureau for the Safe Transportation of Explosives, a nonprofit private organization devoted to establishing safe transportation practices for explosives and other dangerous articles, and with other transportation specialists. On the basis of the known reactions of explosives and other dangerous articles to variations and extremes of temperature, pressure, and shock experienced in transit, certain articles have been selected as safe for carriage by air. With exceptions as noted these articles include all those which may be shipped by rail express, although there are certain limitations prescribed on the amounts of some of these substances which may be shipped by air.

While it is believed that the items deemed acceptable in Part 49 include most of those which may be safely carried, further laboratory tests are being conducted by responsible industry and government agencies, and as results of these tests are made known some additional items may be added to those which may be carried.

It will be noted that this procedure is similar to the one followed by the Interstate Commerce Commission. On behalf of the Commission, the Bureau for the Safe Transportation of Explosives analyzes new products and new packaging methods as they are developed in order to permit new items to be shipped by surface transportation and to improve the safety with which existing items are carried. The testing limits presently used by the Bureau for the Safe Transportation of Explosives for rail express compare with actual conditions encountered in air transportation with the possible exception of certain pressure tolerances.

With respect to the effects of reduced pressure on articles coming under the provisions of Part 49, substances which might be affected by pressure changes either are not permitted on aircraft or are permitted only when packed in pressure resistant containers.

Meanwhile certain agencies, including Wright Field, are conducting research on the subject of pressure sensitive materials. The results of their research will be made available to the Board. It will then be decided if any of the restrictions imposed by Part 49 on pressure sensitive materials can be modified.

The Bureau for the Safe Transportation of Explosives has agreed to furnish the Board with such information as it may obtain from time to time with respect to the handling of explosives or other dangerous cargo, and the Board intends to introduce appropriate changes in the list of acceptable articles for air transportation on the basis of this information and such other data as is made available to it by interested industry groups. In this manner it is believed that lists of acceptable articles may be kept current.

Generally the proposed new part differs from present Part 49 in the following manner: The part will base Civil Air Regulations on the provisions of current ICC Regulations rather than those in effect on a particular date. It will distinguish between articles acceptable on aircraft carrying passengers and articles which may be carried in cargo-only operations. The revised part permits the carriage of an enlarged number of classes of articles in passenger-carrying aircraft. On cargo aircraft almost all of those substances authorized for shipment by rail express service may be carried. At the same time levels of safety have been raised by the prohibition of certain articles permitted by present Part 49 and by the imposition of more restrictive packaging requirements and quantity limitations.

For passenger-carrying aircraft, only those classes of articles listed in section 49.10 of the proposed rule may be carried. The part specifies the packaging and labeling requirements for each of these items since many of these articles are exempt from the usual ICC Regulations packaging and labeling requirements. New classes of articles to be carried in passenger aircraft would have to be added by amendment of the part. Certain articles which might otherwise be included within the classes of articles which are trans-

portable are specifically prohibited from shipment in passenger-carrying aircraft. The list of such articles will be kept current.

For cargo-only aircraft, in addition to articles which may be carried in passenger aircraft, any article may be carried which is listed as acceptable for mail express in Part 72 of the ICC Regulations provided that its carriage is not prohibited by section 49.81. The Board will be advised of all new items to be added to the acceptable list by the ICC so that it may take appropriate measures to regulate or prohibit the carriage of any items deemed an undesirable risk for air transportation. However, unless the Board does take contrary action, any article may be carried as added from time to time.

In all operations, the revised part will require explosives and other dangerous articles to be packed, labeled, and loaded as specifically provided therein or in accordance with the requirements of the ICC Regulations for rail express. We have required that the packing requirements for rail express be used because they are considered more appropriate for air transportation than those applicable to rail freight, as they provide a higher margin of safety against changes in temperature, pressure, and inadvertent damage and shock while in transit.

It is believed that the differences between all-cargo and cargo-passenger operations are of such a nature as to justify less stringent requirements for cargo flights than for mixed operations. Primarily, the difference in the limitations imposed on the two types of operation lies in the maximum quantity provisions which permit small amounts of articles in combination flights and somewhat larger quantities of these materials in all-cargo operations. In addition, a few items are authorized for carriage in cargo flights that are not considered suitable for mixed operations. It will be noted, for example, that in all-cargo operations the cargo can be under surveillance of the crew members since cargo is located in the cabin of the airplane, whereas in joint passenger-cargo operations the cargo compartment, while technically accessible, is not under the eye of the crew. In passenger

operations it is, therefore, more difficult to detect such an item as a leaky container or a broken package. In any case, authorization to carry items acceptable for rail express on cargo-only operations is essentially conservative. Rail express requirements are based on the fact that there are many combination cars carrying passengers and express in railroad service, and in point of fact the proximity of passengers to cargo in such cars is somewhat similar to that of crew members to cargo in cargo aircraft. Furthermore, railway express regulations tend to be very conservative since there is an alternate method of shipping dangerous commodities by rail freight. The Board, therefore, believes that these regulations provide appropriate standards of safety for cargo-only and mixed passenger-cargo operations.

It is believed that the safety standards established by this proposed revision are adequate for all known extremes of temperature, pressure, and shock encountered in normal flight by United States operated aircraft throughout the world. However, some special operations may require additional safeguards. When such conditions exist, it would be the responsibility of the operator of the aircraft to evaluate these conditions for a particular operation and to require such special packing and handling as may be necessary to insure safety.

It is expected that all air carriers who may now have tariffs in force which purport to authorize packing, labeling, or shipment of explosives and other dangerous articles contrary to the provisions of revised Part 49 will withdraw such tariffs prior to the effective date of this part. As a further service to the industry, it is expected that a manual of recommended practices for the handling of explosives and other dangerous articles will be published by the Government. While such a manual is not essential for the safe transportation of these articles, it is believed that it will perform a useful service for those air carriers and shippers whose past experience with such cargo is limited.

# POSTAL MAILING OF RADIOACTIVE MATERIALS

(Regulations of U. S. Postmaster General,  
The Postal Bulletin, p. 2, Washington D. C.,  
19 April 1949)

## RADIOACTIVE MATERIAL--WHEN MAILABLE

Insert 781--Order No. 40298: Dated April 13, 1949.

Section 588, Postal Laws and Regulations of 1940, as amended, is further amended by the addition of paragraph 6 to read as follows:

6. Radioactive materials (liquid, solid, or gaseous; manufactured articles such as instrument or clock dials of which radioactive materials are a component part; luminous compounds; ores and residues) which fulfill all the following conditions shall be accepted for mailing provided they are properly packed in a strong tight outside container and marked "Radioactive Material-Gamma Radiation at Surface of Parcel Less than 10 Milliroentgens for 24 hours-No Significant Alpha, Beta or Neutron Radiation."

(a) The package must be such that there can be no leakage of radioactive material under conditions normally incident to transportation in the mails in sacks.

(b) The package must contain not more than 0.1 millicurie of radium, or polonium, or that amount of strontium 89, strontium 90, or barium 140 which disintegrates at a rate of 5 million atoms per second, or that amount of any other radioactive substance which disintegrates at a rate of 50 million atoms per second.

(c) The package must be such that no significant alpha, beta, or neutron radiation is emitted from the exterior of the package and the gamma radiation at any surface of the package must be less than 10 milliroentgens for 24 hours.

(d) The design and preparation of the package of radioactive material must be such that there will be no significant radioactive surface contamination of any part of the container. Liquids must be packed in tight glass, earthenware, or other suitable inside containers surrounded by an absorbent material sufficient to absorb the entire liquid contents and of such nature that the efficiency will not be impaired by chemical reaction with the contents.